# MENTAL INHERITANCE

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Reprinted from the Popular Science Monthly, November, 1909.

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OUR chapter of Sigma Xi has recently invited to its membership some two score persons who have shown themselves to be possessed of such talents and aspirations as the society honors and rewards. Of these new members many have finished their preparatory studies, and are entering upon the independent work of science. It is therefore suitable upon this occasion that we should consider some one of those qualities that distinguish the person who is engaged in the scholarly pursuit of knowledge. The quality which I have selected is the possession of temporal or historical perspective; and I propose to use, by way of illustration, the subject of mental inheritance.

Nothing is easier than to exalt beyond its due the present moment. The present is so vivid, so impressive, so intimate, so important for action, as to compel attention; and current means of communication succeed so well in bringing distant lands and deeds within our field of vision that the whole world contributes to the fascination of the passing scene. We all realize this fascination, however much we may set our faces against the vulgar homage paid to the latest mode, the most recent invention, or the last political experiment. We realize it, and, if we are wise, we perceive that the philistine passion for being "up-to-date" (as the street-phrase has it) contains an element of great value—the element of enthusiasm. Scholarly work demands enthusiasm, and every epoch of science has, and, I suppose, will have, its sanctions and its rewards for enthusiastic endeavor. In this regard our own time certainly is not wanting. At a period when the constitution of matter and its elementary forms have, by the discovery of new facts, been brought to the focus of attention; when the development of living forms through their various stages of growth is observed by methods undreamed of by the earlier historians of nature; when the study of evolution has advanced to the stage of analysis and experiment; when the earth is revealing significant traces of primitive man and his works; when psychology proposes new methods for the study of thought and action and for a comparison of the human with the animal mind; when, finally, philosophy rests less upon the authority of great names and systems than upon the immediate data of experience, no ardent novitiate in science can complain that fate has thrown him upon an age of

[1] An address delivered before the Cornell Chapter of Sigma Xi, June 9, 1909.

platitude and dogma, or has denied to him the opportunity of spending his energies in the cultivation of a land of promise.

The kindling enthusiasm of the man of science must not, however, be confused with the philistine's boast that history is a wreck from which only he and his time have been saved. Opportunity which inspires the scholar inflates the time-server and intoxicates the anarchist. The difference between these persons rests at last upon temporal perspective, or the want of it; for it is the apprehension of new opportunities and new needs in the light of old accomplishments that leads to profitable reconstruction of human knowledge. In mechanical invention, the new model may cause the old to be cast upon the rubbish-heap; but in man's interpretation of the world, old theories and old points of view which have served their generation are never discarded; they still mark the stages of human acquisition and take their place in the development of science. Without a knowledge of them, and of their relation to present problems, no man, however ingenious or fertile, should hope to do more than a journeyman's work in the free advancement of learning.

But even when we know the general history of thought and the special histories of our own small divisions of human knowledge, we are apt to overlook the fact that, in a large sense, civilization itself is a matter of the moment, which may be viewed in the light of a broader perspective. Civilization we measure by hundreds and thousands of years. For example, we trace the Mediterranean cultures eight or ten or twelve thousand years, and then we lose the thread; but the whole history of man we reckon in geological epochs. We find his footprints stamped everywhere upon the Quaternary earth, and we find what appear to be vestiges of him in the deeper deposits of the Tertiary. Throughout the brief day of his written history we study him in a long series of related disciplines which we call "the humanities"; while we hand over the unmeasured period of his whole antecedent career to the single science of anthropology. We glance with admiration at his morning work in iron and bronze and brass, his noontime of Athenian culture, his late hours of reflection and invention, and we seek however feebly to illumine the night of his future; but we tend to overlook the antiquity of man, the record of other days and years, and to avoid the question whether civilization is not, after all, still in the experimental stage—whether we ourselves are not next-door neighbors to the barbarian.

When we regard the rapid accumulations of a few thousand years of culture, we realize that civilization lays upon the human mind a staggering load of traditional knowledge and traditional duty. In "Darwinism and Politics" the late Professor Ritchie has defined civilization as "the sum of human contrivances which enable human beings

to advance independently of heredity." Contrast man and other animals. The animal carries over from his parents and from his racial stock the physical equipment and the functional tendencies which enable him to fight the battle of life precisely as his ancestors fought it. If his type varies under natural conditions, it varies so slowly that, as a rule, many generations are required to disclose the change. With man all this is different. As I just now observed, nurture is cumulative. Each succeeding generation takes up its heritage, not where the preceding generation began, but where it left off. Each has to advance by first absorbing the new attainments of its immediate ancestors. In a real sense, therefore, because he has language and books and institutions and traditions, man is

the heir of all the ages.

Notice, however, that man comes into his social heritage only by acquisition during his individual life, by his own individual efforts. Is he, now, as a conscious being, better and better endowed as time goes on for the process of absorption? Does talent grow as knowledge grows? Does mental capacity keep pace with social accumulation? May we not suppose that the men and women of some distant glacial age, who dwelt upon the ice, wore the skin of the seal, and ate raw fish, had as much brain and as generous a measure of talent as have their remote descendents who wear sealskins, and eat ices and caviare? We can not say that they had not. On the contrary, our records, so far as they go, indicate that the social heritage has outstripped the hereditary growth of mind—that, as regards mental endowment, we begin very much as our distant forbears began; only, we proceed at once to burden ourselves with information and obligation which for them did not exist. To compass languages and sciences and histories and arts, and a complicated social and political régime, we are supplied with virtually the same minds that primitive man used for his primitive wants. Is it any wonder, then, that education is the central problem of an advanced civilization?

The question has been raised, however, whether it is not time to look beyond education to the possibility of improving the human stock; whether education is, after all, the only way of civilizing the individual. When the garden vegetable or the domestic animal fails to meet our needs, we improve its breed—so the argument runs; we breed for size, for strength, for flavor, for color, for endurance, for speed, or for general service. When we find that the part of our human stock which is best fitted to carry the cumulative load of civilization is weak, or degenerate, or inclined to sterility, why do we not look to the improvement of those strains that are mentally fittest and to the elimination of the bad? The argument, you observe, assumes that mental endowment and mental capacity are heritable possessions. Is the as-

sumption warranted? We can not say until we have examined the present status of the problem of inheritance; but whether or not we are pessimistic as regards the future of the race, we must agree that the sudden and increasing burden which culture places upon the human mind raises this problem to the first rank of importance.

Suppose that we look, then, at the grounds of belief in the hereditary transmission of mind. The belief itself stands among the fixed convictions of common sense. In our every-day thinking we take it for granted. The child, we maintain, inherits its father's bad temper just as it inherits its mother's good looks. We consider twice before we adopt the foundling, which may be of dull or vicious parentage. We shake our heads over the wayward son, remembering that his father "sowed his wild oats," and we observe "like father like son," or "blood will tell." We expect to find talent in the children of the gifted, thrift or dwarfed intellect or high purpose, according as these qualities are "bred in the bone." The folk-tale of paupered prince or stolen princess who never, though reared as swineherd or scullion, loses regal bearing and courtly demeanor, the wide respect for royal blood, and the easy belief in the "born criminal," alike testify to the common and venerable persuasion that minds, and even morals, are subject to hereditary transmission.

It is only when we stop to inquire precisely *what* is inherited in all these instances, and how it is conceivable that mind should pass from parent to offspring, that we leave the highway of common sense and enter the more difficult path of critical observation and induction. It is obvious that a clear statement of the problem and a forecast of method are of the first importance.

Inasmuch as the notion of "inheritance" involves both the process and the products of transmission, the *inheriting* and the *thing inherited,* a choice of methods is at once suggested. Shall we—that is to say—seek to describe the mechanism of inheritance, or to discover the like qualities that have actually appeared in successive generations of blood-relatives? It is quite impossible to state the alternatives without adverting to the fact that biology has, for a half-century, been absorbed in the parallel investigation of physical inheritance. Nor are we likely to forget, in the midst of our commemoration of Darwin's birth and of "The Origin of Species," that the whole doctrine of organic evolution rests upon the facts of heredity. Whatever the factors that determine racial descent—fluctuating variation, or the sudden change of type, use and disuse, natural, artificial, sexual or organic selection—both continuity in the process of bionomic change and maintenance of the change once produced, demand the conception of a hereditary likeness. Without inheritance the establishment of a stock would be impossible, and without a stock, variations and mutations

would be chaotic and without significance. Thus, ever since Darwin's own attempt at a theory of heredity, we find the students of organic evolution and the breeders of plant and animal races alike devoting themselves to the problems of racial and individual inheritance.

Now it is plainly futile for the psychologist to pretend to first-hand knowledge in a field which is not his own; but, on the other hand, it is equally foolish for him to proceed to the question of mental inheritance without a conception of the methods used, and of the general progress made, by the biological sciences in like inquiries. He must at least bear in mind that the days of pangenesis were followed by the days when Weismann challenged the Lamarckian doctrine of use and disuse, these by the days of rapid development in cytology (the science of the cell and its development), and these days, in turn, by the establishment of the science of genetics and of a revised, if tentative, doctrine of heredity. He must also keep in view the general march of events that led up to the rediscovery of Mendel, the attempt to establish "unit characters" and to segregate the elementary factors in descent, the exploitation of sudden or discontinuous variation at the expense of fluctuation, and the wide use of Quetelet's discovery that individual variation follows the law of probability.

But what, you may ask, has psychology to learn from the doctrine of physical inheritance, when bionomic orthodoxy is overgrown with speculation, when evolutionists themselves are asking, fifty years after Darwin, whether the time is yet ripe for a discussion of the origin of species, when they are raising the doubt whether there has yet fallen from the tree of knowledge the apple that shall suggest the discovery of the universal law of inheritance; when Strassburger affirms that the doctrine of heredity must rest upon the study of the cell, and Bateson replies that the student of evolution is "still, as a rule, quite unable to connect cytological changes with any genetic sequence," and that the direct examination of parent and offspring, not of the germinating cell, is the present key to the problem? What can the psychologist hope to learn about method when the biometrician and the follower of Mendel stand at sword's points; the one fighting for measurements, and schemes of distribution, and coefficients of correlation, and the other for segregation, unit characters and laws of dominance and recession?

My reply is, first, that, in spite of his keen enjoyment of the battle, even the observer from the outside can appreciate the invention and application of clever and useful methods and the advancement of knowledge through conflict; and, secondly, that the student of mental inheritance must get at least half of his equipment from the antecedent studies of biology. To be sure, he finds his material within psychology; but he sees that the strict dependence of mental upon physical derivation calls for an alliance with both the biometrician and the student of physiological genetics.

Let us be more concrete in this matter. If I catch the drift of biological discussion (a hazardous assumption, it may be, for the layman in biology to make), no current and generally accepted doctrine of heredity is able to trace in an unbroken series of structures or events the details of the parental organism through the stages of reproduction to the corresponding details of the offspring. The nuclear and non-nuclear substances that are supposed to represent the "vehicle" of heredity do not, I think (except, perhaps, in a few cases) show variations that represent and correspond to the likeness or difference in given characters as these appear in parent and offspring (*e. g.*, differences in height, in shape of leaf, or in color of hair). If, at some future time, these variations are discovered, then they will, I suppose, represent or correspond to mental as well as physical likeness and difference. At present, however, degree of likeness in blood-relations must be derived from description or measurement of corresponding characters or qualities to be observed in succeeding generations. And the point at which we are here aiming is this: the establishment of inheritance of these qualities, whether physical or mental, must, in principle, rest upon one and the same basis. The inheritance of eye-color and the inheritance of memory-type, the inheritance of an "athletic build" and the inheritance of a bad temper are facts of the same order, and similar methods may be laid under prescription for their establishment.

The great difficulty lies here: how are the characters, mental and physical, to be conceived? and how are they to be described and measured?

We have just seen that upon this question of analysis and measurement, quite apart from the problem of mechanism, the schools of evolution show wide differences of opinion, the biometrician basing his method upon the doctrine of probabilities and proceeding quantitatively, the Mendelian basing his method upon the doctrine of unit characters and segregation and proceeding analytically and by distinction of qualities.

Which of these methods, if either, is psychology to adopt? It happens that psychology has already made a provisional choice; or rather, a choice has been made for her. Biometry has been predominantly concerned with human, Mendelism with non-human, inheritance. It is scarcely an accident, then, that biometrical methods were the first to exploit the mind of man. As you know, biometry's inspiration came from Francis Galton, traveler, explorer, geographer, anthropologist, student of evolution, psychology and sociology. The grandson of Erasmus Darwin, a representative therefore of one of the highly gifted strains of English blood, Galton has devoted himself to a quantitative study of the inheritance of talent and intellect, and to practical measures for purifying and improving the race. His interests revolve

about the central theme of human ability and its dependence upon the stock. In a study of three hundred eminent English families, Galton found the descent of great mental capacity to be far more intensive than in less eminent families; and found, further, that the closer the blood-relationship, the greater was the number of eminent individuals. Later studies, for example, Galton's own recent inquiry into the family history of Fellows of the Royal Society, have likewise shown that the person of superior mind is much more likely than the average to possess superior ancestors and descendants. These facts are justly interpreted as an indication that mental endowment depends in large measure upon direct inheritance.

This kind of inquiry then—the kind that takes human beings in the mass and applies a rough unit of measurement—reveals in a striking way the importance of the hereditary factor in mental ability. However, the method does not constitute a science of heredity. No evolutionist would be satisfied to know that large horses beget large horses, and small horses small horses. It is the degree of likeness of some particular organ, or quality, or function, or peculiarity that the student of heredity now attempts to state, and to state often in numerical terms.

So the present psychological problem of heredity comes back to the question of mental characters and of the best methods for their description and measurement. The psychologist may answer this question in either one of two ways. First, he may fall back upon the distinctions of every-day or popular psychology and say that "a good memory," "sound judgment," "conscientiousness," "affability," "sentimentality" and "industry" are mental characters, and that the way to calculate their heritability is to take a large number of persons, related and not related, estimate the eminence of these qualities in each, note their distribution and derive laws of resemblance. If you find that a good memory, or affability, or industry "runs in families," and is not to be attributed to a common environment, you may conclude that the characteristic in question is heritable. As a matter of fact, this is the method that, for the most part, has been employed within the last ten years; and it has been used either by biometricians themselves, or by the psychologist who has followed their initiative.

Let me cite two or three instances. Professor Karl Pearson, of the University of London, the leader of the biometrical school, collected from teachers data regarding some four thousand children. Color of hair and eyes and cephalic index were among the physical characters graded, and conscientiousness, temper and assertiveness among the mental traits. The degree of likeness between brothers and sisters was found to be substantially the same for physical and mental qualities; in Pearson's terms, each showed a correlation of about 0.5. Again,

Professor Thorndike, of Columbia University, in a study of fifty pairs of twins, by the use of tests and measurements, derived nearly the same degree of correlation (just exceeding .75) for mental and physical characters—a much higher degree of resemblance, by the way, than he found in brothers and sisters *not* twins. The result is noteworthy, even though we may doubt the full validity of the method. The most extensive and painstaking investigation of this order was recently made by two Dutch psychologists, Heymans and Wiersma, of the University of Groningen. Some four hundred physicians responded to a questionary, each giving the results of his intimate acquaintance with a single family. The questions asked pertained to the ardor, impulsiveness, resolution, persistence, generosity, temperance, wit, patience, industry, etc.—about ninety topics in all—of each member of the family selected. The results when thrown into tabular form indicate a high degree of resemblance between parent and child—a higher resemblance between father and son, mother and daughter, than between father and daughter and mother and son. Even after allowance had been made for cultural influences, the degree of likeness was about the same as the inheritance of bodily stature, and the result seems, moreover, to stand in close agreement with Galton's law of ancestral inheritance, which accords to the average parent one quarter the heritage of the offspring.

It is, now, a matter of interest that these studies and others that might be brought under survey suggest that our mental traits and capabilities are derived, very much as are our bodily characteristics, from hereditary endowment. You must, however, have been struck by the grossness of the method of collecting facts. What is the scientific value, you may have asked yourselves, of a teacher's or physician's opinion that *A* is more vivacious or less generous than *B*? Well, the outcome does show, I think, that careful mathematical treatment of extensive data thus collected will yield noteworthy and valuable results. But the more important the results, the greater the demand for refinement of method. Can the method be improved? I think that it can. The biometrician having shown that the problem is capable of solution, let us see if his arch-enemy, the follower of Mendel, can not suggest the improvement in procedure. The improvement that I find suggested is this: the exclusive inheritance of Mendel lays emphasis upon the analysis and separate treatment of individual characters. Now without presuming to decide whether inheritance takes place in all cases, or even as a rule, through the recombination of "unit characters," mental or physical, psychology may profit by the Mendelian principles so far as to insist that inheritance be studied, not in the gross, but in terms of definite and measurable mental structures and functions.

This insistence involves the substitution of a doctrine of mental characters for the popular conception of vague and indefinite traits and peculiarities. How is this doctrine to be derived? Obviously from psychology itself. Neither biometry nor biology nor common sense can furnish the materials.

Look with me for a moment, if you will, to see what psychology has to offer. It is evident that the general psychology of the average normal mind will not suffice when the matter is one of defining *differences* among minds of the same class. Just as physical inheritance must take account of arrays and schemes of distribution, and not of averages, so must mental qualities and magnitudes be arranged with respect to definite individual variations within the class.

A psychology of individual differences is thus invoked; and a psychology of individual differences does exist; or rather, it is in process. The way of scientific description is first to reveal uniformities hidden in the mass, and afterward to seek the rule of variation from the average. General psychology, taken in this sense, is accordingly the older branch of the science—the psychology of what is common to all minds—individual psychology, the newer. So it happens that although the older branch of the science has a well-developed metrical technique, established at almost the same moment that "The Origin of Species" appeared, its quantitative determinations are determinations of psychophysical *constants* and not laws of individual variation. These laws can not then be used (at least not directly) for the statistical study of inheritance. What is needed is a psychology of typical differences, and this it is that individual psychology is by way of supplying. Let me, in a word, indicate its method. It proceeds by experiment to take the dimensions of mind as regards variable functions, *e. g.,* the maximal amount read in a given time and under given conditions, or the number of words remembered or of figures added. The first results show typical differences as between mind and mind. The experimenter next proceeds to factor the performance into elementary processes and functions. By drawing his conditions closer and closer he discovers that the capacity for reading depends upon such simple factors as the range of consciousness, the degree of attention, and the temporal rate of visual processes, factors all capable of measurement and exact description. He discovers that remembrance depends upon the employment of visual or auditory or kinesthetic processes, *i. e.,* that in one observer an eye-mind, in another an ear-mind and in a third a muscle-mind is employed. Of these factors, he can predicate heritability. It is as if "criminality" were reduced to a lack of motor control plus an abnormally intensive passion or lust. "Criminality" would then never be inherited, but the constituent factors might very well be. The method of individual psychology, however, goes farther. After

having reduced a conscious experience to simpler terms, the process of reconstruction begins. The functions and processes that have been reduced to numerical terms are recombined in their several amounts and the integration when complete represents an individual in so far as that individual is typical. With the absolute and exhaustive description of the individual as such, science is not concerned. Typical minds thus derived are, so to say, minds of different length and breadth and thickness. They are analogous to the variable organs and functions of the body. Their scientific description differs from the crude characterizations which we pass upon our friends and enemies as the law of falling bodies differs from an observer's account of a balloonist's accident.

The steps, then, in the procedure of individual psychology are (1) the measurement of a group of mental processes or functions, (2) analysis for the discovery of elementary or fundamental differences, (3) integration of these differential factors, and (4) a classification of types; measurement, analysis, integration, description, a common and justified sequence in the general methodology of science. Compare with this procedure the instances taken a few moments ago from the psychology of common sense—the method employed, let us say, by Pearson. The first and the last steps are combined ("conscientiousness" or "assertiveness" represents the type), analysis and integration are omitted, and an offhand estimate is substituted for careful measurement.

I fear that I have been tedious and that I have perplexed you overmuch with matters remote from your primary interests. My excuse is that I have given you in part a program for the future, and that methods in the making are notoriously self-conscious and awkward of expression. If it were ten years later doubtless I could display more product and vex you less with the process. I could, I have reason to believe, show you this psychological problem of ours, which already at the early stage of crude quantification has proved itself extremely fertile, in a much more mature and fruitful state.

Now that you have before you, in outline, the problem of mental inheritance, its debt to biology, and the present necessity—if the problem is to advance—for the analytical treatment of traits by a science of individual differences, let me in closing return to my earlier remarks touching the import of inheritance in human history. I urged that human knowledge and human obligation have grown out of proportion to human talent. So far as we can tell, the child of to-day possesses the same nervous system, the same sense organs, evinces the same instinctive tendencies, in short, develops with the same physical and mental equipment as the child of unnumbered generations ago. If, so far as education went, the primitive boy was ready for man's estate at

twelve or fifteen, can we wonder that at present the candidate for an advanced university degree has often passed his thirtieth birthday? We should rather marvel at the elasticity of the mind's response to new needs. We know that Quaternary man sometimes possessed artistic ability—perhaps as great ability as the modern European; but what a difference in the product. We can not conceive a medieval musician—to go no further back—producing or comprehending our operas and symphonies; but who would say that native ability in music has grown in the meantime? Are we not then driven to the admission that no principle of selection has for a long time been sufficiently active to raise the level of mental endowment? We live on capital gathered and hoarded by the race. Suppose that we turn spendthrift! Francis Galton reckons that England at its best falls two grades below the highest intellect of Athens; that England produces one man of supreme eminence where the older culture produced two hundred. Suppose that by improving the breed our mental endowment should recover those two grades. The effect, direct and indirect, upon the race is not easily estimated. It is conceivable that it should give to every generation a Homer or a Dante or a Shakespeare, and to each of the European states and America a dozen Newtons and Darwins. Eugenics rests upon a scientific basis and it proposes a well-considered program for future activity. Whatever differences of opinion we may hold regarding the probable success of its methods, we must agree that civilized man may not indolently regard himself as "God's domestic animal"; that he will, on the contrary, do well to examine and to estimate the hereditary factor in his own mental development and to seek to combine for his improvement the conjoint forces of nature and nurture.